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EASTERN EUROPE'S RELIANCE ON WESTERN TECHNOLOGY

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I. SUMMARY

This paper provides an assessment of East European reliance on high-technology imports from the West.[1] In section II, a measure to provide a relative scale of reliance on Western imports for a sample of commodities is calculated for each of the six East European members of the Council for Mutual Economic Assistance (CMEA) as well as for the Soviet Union and Yugoslavia over the period 1980-1984.

Section III provides a measure of overall reliance for each country by aggregating over the group of commodities discussed. This measure is then compared with a similar measure for all machinery to determine if reliance on these commodities is greater than on the general category of machinery imports. The section discusses the relative importance of these commodities to Western countries as exports.

Section IV presents a brief case study, the importation of machine tools by Hungary. This use of additional data sources provides a check on the relation between the import reliance measures and the actual flow of imports to Eastern Europe.

Section V offers the study's conclusions.

II. EAST EUROPEAN RELIANCE ON INDIVIDUAL COMMODITIES

It is difficult to frame an operational definition of import dependence that permits unequivocal statements about the relationships that actually exist between trading nations. Colloquial use of the term *dependence* often goes beyond its narrow economic sense; the meaning it conveys is also inherently a political one. Even if it can be shown unequivocally that a specific policy of denial will lead to costs or reduced efficiency being imposed upon an erstwhile trading partner, at what level can such costs be said to be unacceptable? Clearly, the

[1]This article summarizes research presented more fully in *East European Reliance on Technology Imports from the West*, by Steven W. Popper, RAND Report R-3632-USDP, August 1988. It will appear in the forthcoming report to the Joint Economic Committee of Congress, *Pressures for Reform in the East European Economies*.

answer depends on the choices made by the target's political leadership. If the response is to bear the costs and alter relations in the domestic economy rather than modify other behavior in the face of an embargo, it is difficult to say that a nation is dependent on the severed trade tie in the simplest sense of the word.

This study does not confront the complexities of the larger question of dependence on the West for higher-technology goods. It is limited to a determination of the revealed reliance on Western imports by individual East European countries for specific categories of high-technology goods.

The import reliance measure is calculated by aggregating the total imports from developed Western countries[2] for each disaggregate commodity group and dividing this value by the total for all imports in this category from both the West and the CMEA. The measure is stated as a ratio, with 1.00 the theoretical maximum (all imports in the category come from the West) and 0.00 the minimum. All data are derived from statistics compiled annually by the United Nations Economic Commission for Europe (UNECE) for the years 1980 to 1984. Since Soviet data are available only for 1980 and 1983, the basic import reliance measure has been calculated for each year excluding Soviet exports in the denominators. For those two years, a second measure, including Soviet data, is reported in brackets.

The measure was constructed by aggregating mirror export statistics rather than by relying on each CMEA country's import data. This provides more continuity to the reporting across time. It also reduces somewhat the possible effects of idiosyncratic reporting practices on comparisons across countries. This method also allows import reliance measures to be constructed for the German Democratic Republic (GDR) and Rumania, which is not possible using only the official publications of those countries.

The method is intended to provide a means for comparison. It should not be interpreted as a precise measure of the *absolute* levels of import reliance since the denominator cannot include imports from all

[2]This procedure is detailed in the Appendix, and the commodity groups are also discussed.

sources.[3] These figures do constitute relative measures that can be used to compare different degrees of reliance across countries and over time.

The statistic measures reliance on the West as a source of imports. It says nothing about reliance upon imports in general. A high relative import reliance implies that much of what is imported in a given category comes from the West, not necessarily that there is a great absolute dependence on imports of that commodity. By the same token, even when absolute import levels are not great and reductions in Western imports may not appear large in terms of total consumption by domestic industry, bottlenecks may cause greatly magnified effects.

Selected Findings By Commodity Group[4]

Centrifuges, Filtration Apparatus, Pumps for Nonliquids, Compressors. The data for this group of goods are reported in Table 1. These goods show generally high import reliance measures relative to other goods in the sample. These commodities often require careful machining to precise tolerances, yet are not subject to severe export controls. Yugoslav reliance on Western deliveries in total imports is almost 1.00. The measure for Hungary is also high and increases from 1980 to 1984, while that for Bulgaria shows the greatest increase. The measure for the GDR rose over the period, while Czechoslovakia's showed little change. Among the six East European CMEA countries, only Poland and Rumania showed a decline during the period, and the overall Polish decline was nominal, with a dip in 1981. Rumania's 1984 import reliance measure for these goods is still higher than its reliance measure for any other commodity group in the technology sample.

The evidence suggests that this category contains high-technology goods that either are not produced in sufficient variety in the CMEA or r are of higher quality in the West. In the absence of export controls, current reliance on this technology is comparatively high. The difference between the import reliance measure for Yugoslavia and that for the CMEA in general (ranging from 0.10 to 0.45) may in this case be

[3] See the note on country data in the Appendix.

[4] See Popper (1988) for a fuller treatment of all commodities included in the sample.

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attributable more to the ongoing trade patterns dictated by CMEA institutions (and a concomitant orientation by Yugoslavia toward Western markets) than to export differentiation by Western nations.

Metal-Working Machine Tools. This category includes traditional, manually controlled varieties as well as higher-technology, numerically controlled (NC) machine tools. Many NC machine tools are on the export control lists of the West. The trade data do not distinguish between these categories, even at the five-digit SITC level. The simplest hypothesis is that for most of Eastern Europe the tendency would be to import the less-complex machines from CMEA partners rather than the West because of the difference in cost. Only more advanced, higher-quality tools that are not readily available from CMEA partners are worth the expenditure of hard currency necessary to import them from the West.

Machine tools are the archetypal producers' good. They are the machines that make other machines and are an essential engine for driving economic growth. The ability to produce high-technology machine tools has been a prime desideratum of the CMEA, and a great deal has been invested in attempting to achieve this ability. NC machine tools integrated into flexible manufacturing systems with the addition of robotics are a major thrust of CMEA's Comprehensive Program in Science and Technology and the subject of its first multilateral joint venture, INTERROBOT. Investments to increase the capacity of the Soviet Union to produce higher-quality machine tools in greater quantities have been made the cornerstone of the Gorbachev investment program. The Soviets are also eager to receive machine tools from East European manufacturers that come closer to world standards of technical quality.

Machine tools are also of interest because they form the single largest category of Western high-technology exports to the CMEA. In 1983, they accounted for 2.3% of total Western exports to Socialist countries and 20% of all high-technology exports, as defined by the U.S. Department of Commerce (Lenz and Stiltner, 1985).

The data for machine tools are shown in Table 2. The import reliance measures for machine tools are relatively high, but unlike those for centrifuges and filtration apparatus, they decline between 1980 and 1984. During this period, the measure for Yugoslavia, again

the country with the largest import reliance, declined only slightly. Like most of the East European CMEA, Yugoslavia suffered from balance-of-payments difficulties during this period, more severely than most. Although they are not affected by COCOM restrictions, given their trading relationship with the CMEA, the Yugoslavs would probably prefer to be able to import from the CMEA the goods that are not available domestically. Therefore, many of the Western machine tools Yugoslavia imports may be advanced types that are not available from the CMEA.

It cannot be assumed, however, that the observed import reliance stems solely from a difference in technological level. There are practical difficulties in guaranteeing regular shipments from CMEA countries of goods that are subject to chronic excess domestic demand.[5] The mechanism of trade within the CMEA also compounds this with problems of timely delivery, quality control, and service support. These might lead to some purchases of Western machine tools even though satisfactory substitutes are theoretically available from CMEA countries. Nevertheless, the fact remains that the Yugoslav reliance measures in this category are considerably higher than those for any of the other countries under discussion. A portion of the difference between the Yugoslav import reliance measure and that of the CMEA countries must be ascribed to Yugoslavia's ability to import machine tools of a technological quality that would also be attractive to East European importers in the absence of export controls by the West.

Of the eight countries in the sample, only Bulgaria showed a marked increase in the import reliance measure for machine tools, starting from the lowest level in the CMEA in 1980 and achieving the highest in 1984. The apogee was reached in 1983, due, in part, to a strategy emphasizing greater growth in machinery and equipment investment than in total investment, and the absence of the balance-of-payments problem that affected other CMEA countries.

These figures suggest that there may be a relatively high level of fundamental reliance on Western machine-tool imports necessary to maintain reasonable and prudent levels of basic growth in CMEA

[5] It is not clear, however, that all types of machine tools would necessarily fall into this category.

economies. While this is by no means certain, only two countries fell below the level of 0.30 during the period studied, the GDR and Rumania. The GDR's 1984 measure is suspect because of the exclusion of imports from West Germany and because it represents a sharp dip from the steady 0.39 [0.30] registered in 1980 through 1983. The downturn might be explained by East Germany's hard currency liquidity squeeze (which led to greater use of the special bilateral clearing arrangement with West Germany) than of conventional commercial relations with the rest of the West. Rumania's decline can be explained by the fact that Rumanian economic and trade policy at the time resembled less a case of trimming the sails than of scuttling the ship.

A result of some interest in the case of Czechoslovakia and several of the more technically advanced East European countries is the relatively lower attractiveness of Soviet machine tools inferred from these data. The availability of Soviet export data for 1980 and 1983 makes possible the calculation of two import reliance measures, the standard as well as one incorporating Soviet deliveries. The difference between the import reliance measures calculated both with and without these data may be seen in Table 2. Table 3 shows the percentage by which Soviet deliveries reduced the standard import reliance measures in 1980 and 1983. In 1983, when matters of hard currency cost and relative price would presumably be most dominant, Western import reliance measures generally fell, but the relative differences between these measures with and without Soviet exports actually narrowed for several countries when compared to the figures for 1980. In other words, Czechoslovakia, Bulgaria, and even Poland concentrated on filling the machine-tool import gap with deliveries from the non-Soviet CMEA in preference to increasing Soviet deliveries. The ratios of the two import reliance measures for 1980 and 1983 remained more or less unchanged for the GDR and Hungary; only Yugoslavia, marginally, and Rumania, significantly, relied on more Soviet imports relative to the total. The implication is that the rest of the CMEA countries view Soviet machine-tool deliveries less favorably, or rely upon them less fully, than those from other CMEA states.

Automatic Data Processing Equipment. This category can reasonably be said to include high-technology commodities. The current version of the U.N.'s Standard Industrial Trade Classification (SITC) separates less-advanced equipment into other categories. SITC 752 goods are among the most stringently controlled by COCOM and other export control authorities, as is clear from the import reliance measures given in Table 4.

Yugoslavia, not on the COCOM list, had high but falling import reliance measures.[6] The nadir occurred in 1983. Again, the clearest explanation for the decline is severe hard currency balance-of-payments problems. The highest import reliance measure among the other countries was Rumania's in 1980, which fell drastically by 1984. Rumania was not an active participant in the cooperative CMEA computer program and relied as much as possible on Western contacts, including, but not limited to, imports. Rumania also has joint ventures with Western microelectronics manufacturers. It has received preferential treatment in many areas of export control, but many of its requests for exception in microelectronics have been denied. The other CMEA nations that received generally favorable treatment from the West also had the highest import reliance measures. Poland fell from 0.46 to 0.10 [0.08] in 1983 and 0.08 in 1984. Hungary declined from 0.36 to 0.20 during the period, with a dip to 0.15 [0.12] in 1983. None approached the uncontrolled Yugoslav level. Czechoslovakia, a less-favored but nonetheless technologically advanced nation, also declined steadily.

In addition to balance-of-payments problems, there are several alternative explanations for the general decline in import reliance measures for this category. The three most likely alternatives would be increased reluctance on the part of Western exporters to transfer the specific technology desired by Eastern Europe, success in developing dependable substitutes within the CMEA, and importation from outside the developed West.

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[6]The Soviet Union did not report its exports in this category in 1980.

The first hypothesis carries some weight if the gap between Western and CMEA computer technology is growing. A greater CMEA ability to provide for less-advanced types of computers would lead to a decreasing share of imports from the West in the presence of controls on advanced technologies. The second hypothesis, voluntary substitution of increasingly adequate CMEA alternatives, cannot be rejected by the import reliance data. It receives some substantiation from data on the change in the absolute volume of trade. For all countries except Yugoslavia, the total value of imports of computer equipment from both the West and the CMEA increased between 1980 and 1984. If the totals received from the West and from the CMEA are considered separately, they show a sharp increase (100-300%) in the value of total CMEA imports for all countries except Bulgaria. This result must not be taken as definitive, however, because there are serious problems of valuation, and more needs to be known about the pricing of data processing machinery within the CMEA. A comparison of trade figures for 1984 with those for 1980 shows mixed results: a gradual decline in total value imported from the West for some countries, and increases for others. Hungary showed an increase of 18.5%, and the Soviet Union, 33.6%. Bulgaria's import reliance increased by 85.7%. Given that little of this traffic originated in the United States and that the dollar appreciated considerably during this period, it is difficult to say with certainty that the general flatness of the slope for the value of Western computer deliveries means that the physical volume of imports from the West was in decline and substitution was occurring.

Bulgaria, a country without serious balance-of-payments problems in the early 1980s, well-integrated into the CMEA computer program, and making a strong effort to automate production in several industrial sectors, showed nc great difference between the increase in its imports of computers from the CMEA and the increase in its imports from the West. There is no evidence of a substitution away from Western computers to more CMEA deliveries. In fact, Bulgaria was the only country in the sample that showed an increased Western import reliance measure. The strongest statement that can be supported by the data is

that it is not yet clear that a CMEA country seeking modernization of production can forgo imports of microelectronic equipment from the West and rely solely on CMEA sources.

III. OVERALL RELIANCE ON TECHNOLOGY IMPORTS FROM THE WEST

This section summarizes the findings for the commodity groups by extending the method employed in the previous discussion to illustrate overall reliance by individual CMEA countries on technology imports from the West.[7]

Share of Technology-Sample Goods in Total Imports

Assessment of the economic impact of the technology-sample commodities on each East European country is beyond the scope of this study. Nevertheless, it is useful to indicate roughly the volume that these goods represent in the aggregate. Table 5 shows the annual share of the technology-sample commodities in the aggregate amount of machinery imports (SITC 7) from the West. The technology-sample commodities constitute an average of approximately 15 percent of the total. Their share has grown during the period for all countries except the GDR (whose figures are problematic in the absence of West German export data), Rumania, and the USSR.

Trade-Weighted Import Reliance Measures

The import reliance measures for the individual technology-sample commodities were aggregated into a single, trade-weighted import reliance measure for each country. Table 6 lists the trade-weighted Western import reliance measures by year. Yugoslavia's overall measure of import reliance, not surprisingly, is the highest. It remained relatively steady, actually increasing somewhat by 1984. The 1983 measure indicates a slight increase in reliance upon Soviet deliveries. Poland, Rumania, and Hungary began the period with approximately equal overall measures but declined at varying rates. Hungary's measures

[7]The figures for for 1980 are biased in the direction of greater reliance on imports from the West, since export data were not available for all commodities for all the CMEA countries.

declined gradually, whereas Poland's decline was a bit more exaggerated. The drop for Rumania was drastic.

The figures for Czechoslovakia also show a decline during this period; those for the GDR are, again, problematic due to the omission of export data from the FRG, but they also indicate a gradual decline, although most of the loss appears in the measure for 1984.

Bulgaria is the odd man out. From the lowest overall reliance level in 1980, it moved to the highest in 1983 and 1984.

The general decline might be attributable to hard currency current-account problems coupled with the overall decline in Western lending to Eastern Europe in the wake of the Polish events and the world debt crisis. The relative freedom of Bulgaria from these problems and its ability to maintain access to Western credits could partly explain its increasing import reliance measures during this period.

A second hypothesis is that the CMEA was becoming more self-reliant, better able to substitute domestically produced goods for Western technology imports. A third is that after the instructive experiences of Poland and Rumania,[8] the nature of technology transfer from West to East changed, with the East Europeans placing more emphasis on mechanisms other than direct purchase, such as disembodied technology transfers and co-production schemes with Western partners.

It is certain that both of the latter developments were occurring to some degree. The case of Bulgaria, however, suggests that these phenomena were not preponderant. Bulgaria has been striving to develop its industrial base, particularly in machine building, electronics, communications, and the intersection of these sectors, robotics. The data indicate that in spite of any material assistance Bulgaria might have been able to draw upon from CMEA sources or from other avenues of technology transfer, a necessary component of its drive to upgrade industry has been increased reliance upon Western imports.

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[8]While it is not clear that the strategy of increased technology imports *per se* actually played much of a role in the economic collapse of these countries, this nevertheless remains a common perception in the CMEA.

Technology Imports and General Reliance on Western Imports

Do individual East European states rely more heavily on high-technology deliveries from the developed West than they do on Western imports in other areas of machine trade? A measure of reliance on high-technology imports will be divided by a measure of general Western machinery import reliance to yield a new measure, the ratio of import reliance, RIR. That is,

$$RIR_j = TIR_j / MIR_j \qquad \text{EQUATION 1}$$

where

RIR_j = the ratio of import reliance measures for CMEA country j

TIR_j = the Western technology import reliance measure of CMEA country j

MIR_j = measure of reliance by CMEA country j on imports of other Western machinery in SITC 7

The general machinery reliance measure (MIR) is simply the ratio of the value of imports from the West of all machinery and transport equipment (SITC 7), minus the commodity groups previously identified as constituting the high-technology sample, to the value of total imports from both the West and the CMEA of SITC 7 goods each year:

$$MIR_j = \frac{\sum_{n=1}^{p} (Wm_n - \sum_{t=1}^{v} W_{tn})}{\left[\sum_{n=1}^{p} (Wm_n - \sum_{t=1}^{v} W_{tn}) + \sum_{\substack{i=1 \\ \text{where } i \neq j}}^{k} (Cm_i - \sum_{t=1}^{v} C_{ti})\right]} \qquad \text{EQUATION 2}$$

where

MIR_j = reliance by CMEA country j on imports of all other Western machinery included in SITC 7

Wm_n = country j's imports of SITC 7 machinery from Western country n

W_{tn} = country j's imports of technology good t from Western country n

Cm_i = country j's imports of SITC 7 machinery from CMEA country i

C_{ti} = country j's imports of technology good t from CMEA country i

This general reliance measure is similar to the previous aggregate technology import reliance measures, deriving from the same sources and presumably subject to the same biases. In this case, however, the aggregation is a simple average, since resources were inadequate to provide a trade-weighting of reliance measures for all the categories of SITC 7.

To provide uniformity, the measure for aggregate high-technology import reliance (TIR) serving as the numerator in the ratio will not be the trade-weighted number used previously, but rather a simple ratio of the values of imports from the West of all commodities in the technology sample to the total of the technology sample commodities imported from both East and West:

$$TIR_j = \frac{\sum_{n=1}^{p} \sum_{t=1}^{v} W_{tn}}{\left(\sum_{n=1}^{p} \sum_{t=1}^{v} W_{tn} + \sum_{\substack{i=1 \\ \text{where } i \neq j}}^{k} \sum_{t=1}^{v} C_{ti} \right)} \qquad \text{EQUATION 3}$$

where

TIR_j = the Western technology import reliance measure of CMEA country j

W_{tn} = country j's imports of technology good t from Western country n

C_{ti} = country j's imports of good t from CMEA country i

If the ratio of the high-technology to the general machinery import reliance measure is 1.00, it would indicate, at this level of refinement, that the import reliance for high technology was not more pronounced than the general reliance on engineering product imports. A ratio greater than 1.00 would suggest that there is greater reliance on the developed West for imports of the high-technology commodities considered in this study than for the general pattern of the visible trade in machinery. Alternatively, a measure of less than 1.00 would mean that there is relatively less reliance on the West in the technology commodity groups than in the other commodities in SITC 7.

The data in Table 7 indicate that Eastern Europe is generally more reliant on the developed West for higher-technology goods than for other types of machinery and equipment. Yugoslavia and Czechoslovakia show

the least difference between patterns of trade in low- and middle-technology goods and imports of Western high technology. The figures for Czechoslovakia are just below, and those for Yugoslavia just above, the 1.00 mark for the entire period. In the Yugoslav case, the proximity to 1.00 is most likely due to a greater tendency to rely on the West for machinery imports generally, while for Czechoslovakia, it is due to a Western technology reliance measure that is comparatively low by CMEA standards.

The large discontinuity between the measures for 1980 and 1981 is partly due to incomplete data. It may also reflect the sharp change in East-West commercial relations following the Polish events of 1980 and the rescheduling of the Polish, Yugoslav, and Rumanian debts. For most countries, after 1980, the ratio holds relatively constant or increases over time.[9] In other words, beginning in 1981, the ratios of technology-sample commodities to the general pattern of machinery imports show an increasing differentiation in reliance. Trade with Western countries during the years of interest here was becoming more focused on the high-technology goods.

Two inferences may be drawn. They are not mutually exclusive, but both are inconclusive in the absence of further information. The first is that in the presence of hard currency constraints, the import strategies of Eastern Europe emphasized the priority of essential goods necessary for sustaining future growth that could not be obtained within CMEA. The available data are not in themselves sufficient to sustain this hypothesis, but they provide corroboration for work by Crane and Kohler (1985) that refutes the supposition that East European hard currency resource elasticities for machinery are high. These imports are not the first to be cut by the Soviet bloc countries when hard currency is scarce. With this interpretation, the data suggest that the higher the technological level of the machinery, the less elastic is the relative demand with respect to a hard currency budget constraint.

[9]The GDR shows a large dip in 1984, but this is difficult to interpret due to the lack of data on inter-German trade.

The second inference is that to the extent that indigenous CMEA substitutes for Western machinery imports have been developed, they have tended to be at the lower end of the technology continuum. The technology-sample commodities include items that have been the objects of major CMEA R&D efforts: machine tools, computers, communications technology, and microelectronics. It cannot be said that the sample misses areas of primary focus for Soviet bloc development projects. The nondecreasing trend of the ratio of high-technology to general machinery import reliance could thus be ascribed to an increased ability in the CMEA to satisfy the lower end of the bloc's technology requirements, while not affecting a continuing reliance on the West for higher-end commodities.

The case of Poland is instructive. During the course of Poland's economic woes, the ratio of high-technology to general machinery import reliance changed from 0.98 [0.79] in 1980 to 1.28, 1.79, 1.26 [1.39], and 1.20 in 1981-1984. In other words, in a time of crisis, trade in most machinery categories was reoriented to the CMEA, but relatively less so in the technology-sample categories. As the immediate crisis passed, this difference became less pronounced. The figures suggest more prudent control over import priorities, assuming the efficient assimilation of technology inputs, than is usually ascribed to the Polish authorities. In Rumania, the opposite strategy was employed. The higher-technology commodities showed a relatively greater decline in reliance on imports from the West than did machinery in general.

The trends for Hungary and Bulgaria are similar to Poland's, increasing in differentiation, although the Bulgarian increase is more dramatic. Based on the earlier discussion, the similar trends may stem from different proximate causes. In Bulgaria, the increase in the ratio is contemporaneous with an investment strategy emphasizing modernization of the machine-building and electronics (including telecommunications) sectors. If the data are accurate, they suggest that even after the examples of Poland and Rumania in the 1970s, large-scale programs of this type lead to increased reliance on technology imports from the West. This finding is striking in view of the differences in the level

of development between Bulgaria and such countries as Czechoslovakia and East Germany, to whom, it might be expected, the Bulgarians would turn if the necessary advanced equipment were available within the CMEA. Western technology imports may be necessary to fill gaps in the CMEA supply or to provide crucial components necessary to increase the effectiveness of less-advanced CMEA equipment. As an extreme example, there are reports that the GDR now sells some industrial machinery with empty slots for electronic components that buyers must acquire elsewhere (Diehl, 1986). Less-dramatic specific dependencies must also exist.

The Bulgarian data reflect a period of increased deliveries from both the West and the CMEA of machinery and transport equipment, with a relative increase in reliance on the West for high technology. The Hungarian ratio, on the other hand, increased during a period of slow growth and import cutbacks, affecting even machinery and transport equipment deliveries from the CMEA. The decrease in the latter might also have been due to pressure on Hungary to reduce its ruble current-account deficits. The results appear similar to the Bulgarian experience during a time of general import expansion. Such cuts or import controls as did exist appear to have been relatively favorable to the import of Western technology goods. To the extent that there was substitution by CMEA sources for SITC 7 goods formerly imported from the West, this was disproportionately high in categories other than the high-technology sample group.

The data for 1983 allow the construction not only of the same ratios as for other years, but also of analogs in which Soviet exports to Eastern Europe are factored in. In each case, the addition of Soviet export data causes the ratio indicating a difference in trade patterns between the technological and general engineering goods to increase. In other words, for each country, the addition of Soviet machinery deliveries to the CMEA totals accentuates the difference in import reliance on the West for this sample of high-technology goods, compared with the general trade in machinery. Soviet deliveries to Eastern Europe are not weighted in the direction of goods included in the technology sample. The inference from this measure is that Eastern Europe tends to rely more on the West for the higher-technology goods

included in the sample than for machinery imports in general, and more on the European CMEA than on the Soviet Union.

The Role of the West

A major obstacle to developing a unified Western approach to technology transfer is the difference in the consequences of reduced trade for exporting states. In particular, the role played by the United States differs significantly from that played by several of its major allies.

In 1984 U.S. exports of high-technology goods to the CMEA were negligible compared with total U.S. exports. Deliveries of pumps, centrifuges, and filtration apparatus to the CMEA made up only 0.4% of total U.S. exports of these goods. Similarly, only 0.6% of all machine tools exported by the United States were shipped to Eastern Europe. These were the highest percentages for the United States among the technology-sample commodities.

In contrast, West German sales of machine tools to the CMEA, not including deliveries to the GDR, accounted for 17.9% of over $2 billion in total machine-tool exports. Machine-tool sales to the East are not much less important in percentage terms (at least 10% of the total) for France. Italy, Switzerland, and Sweden, all major world suppliers. Austria and Finland each ship half of their exported machine tools to the CMEA.

These differences are less profound for other commodities, although there is still a potential for conflicting policy in some areas. For example, virtually none (0.07%) goes of the U.S. exports of automatic data processing equipment to the CMEA. France, on the other hand, shipped 6.0% of over $1 billion in total foreign sales to the CMEA.

If the values of all the commodities in the technology sample are totaled, for no CMEA country was the U.S. share of such imports from the West greater than 5% in 1984. The average was about half that. The same generally holds true for the individual categories of high-technology goods, with the exception of some communications equipment on categories. Even so, the U.S. share of total Western exports to the CMEA in these categories was 1.5% and 3.6%.

These figures suggest that the current low level of U.S. participation in high-technology exports to Eastern Europe places limits on the ability of the United States to use direct technology exports in pursuit of policy goals. It is possible that the goods actually delivered by the United States are of such a high technological level that the effect of cutbacks would be amplified to some extent. But no matter what the amplification factor, the small proportion of U.S. exports of these commodities means that East European dependence on them has to be fairly low. Unilateral influence can be obtained only by increasing sales of high-technology commodities to the CMEA as a *quid pro quo*, clearly a policy choice requiring the most careful consideration in relation to other policies touching the CMEA countries and to the national interest. Any U.S. action can be effective only as part of a multilateral effort. Policies suggesting the use of technology export restriction or expansion must clearly be coordinated with the other members of COCOM. Coordination is also needed with developed Western states that lie outside the COCOM apparatus, such as Sweden, Switzerland, Austria, and Finland. Attempts by the United States to expand the list of controlled commodities for the goods that are currently traded are almost certain to raise a reaction from Western allies who are more likely to be adversely affected than the United States. Policy choices directly affecting technology trade will most likely be focused on commodities that represent new technologies or new embodiments of older technologies that are not currently traded.

IV. THE ROLE OF MACHINE-TOOL IMPORTS IN HUNGARY: A CASE STUDY

This section illustrates the concept of import reliance with the specific experience of one CMEA country and one commodity. The findings help explore the connection between import reliance as measured and a fuller sense of import dependence.

The case is that of machine tools in Hungary. Hungary was chosen because of the high quality and accessibility of data routinely published in its official statistical series. Machines tools are useful

because the difference in level of sophistication between traditional and numerical control (NC) machine tools is clear; technological taxonomy is certain at least to this level. The year analyzed is 1983, the latest year for which Soviet exports are reported in the UN data.

The Role of Imports

In 1983, Hungary's Western import reliance measure for metal-working machine tools was 0.42 [0.36]. Published Hungarian data were used to calculate a similar ratio corresponding to this measure for the same year. The ratio analogous to the import reliance measure for these machine-tool types is 0.34 [0.28].[10] The two sets of figures are not strictly comparable, since the five categories available for computation from Hungarian data do not represent the full range of machine-tool types falling under SITC 736. Many of these are specialized machines that adhere to higher technical specifications and therefore, presumably, are more readily obtainable in the West, barring export controls.

Domestic sales of "metal-working machine tools" amounted to Ft 2,952 million, while imports of "machine tools and other metal-working machines" amounted to Ft 2,602 million.[11] If the two categories are congruent, imports accounted for 47% of domestic investment. In value terms, one of every eight machine tools emplaced in Hungary in 1983 was imported from the developed West.

The Western machines are more expensive on a per-unit basis than the imported CMEA machines. It is presumed that a portion of these machines embody higher technology than their CMEA counterparts. Reliance on Western machine tools also varies with type. Machine tools with more sophisticated functions, such as grinders and milling machines that operate on multiple axes, tend to be overrepresented by Western imports relative to the average.

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[10]All data in this section, unless otherwise stated, are from *Statisztikai Evkonyv*, *Iparstatisztikai Evkonyv*. and *Kulkereskedelmi Evkonyv*, 1983.

[11]Since exports were reported as Ft 3,905 million in 1983, the figure for domestic sales must apply only to domestically produced machines.

Relative Technological Levels of Imports

The trade in NC machine tools provides a better sense of the qualitative difference between CMEA and Western machine-tool imports to Hungary. NC machines represent a higher technological standard, since they incorporate some type of digital, programmable control system, usually in the form of integrated microprocessors.

According to information obtained from a voluntary association of most of the NC machine-tool-using enterprises in Hungary,[12] a total of Ft 406.3 million worth of imported NC machines was emplaced by their members in 1983. Of this total, Ft 357.5 million--88% by value--came from the West (SPE, various years). These figures for imports from both the CMEA (including the Soviet Union) and the West can be used to construct ratios in which the numerators are the value of NC machine-tool imports from the appropriate area, the CMEA or the West, and the denominators are the respective total import values from each area of the five machine-tool types, both NC and traditional, discussed above. This yields a proportion of 0.05 for Hungarian machine-tool imports from the rest of the CMEA and 0.96 for machine-tool imports from the West. This is not to say that only 5% of machine-tool imports from the CMEA and 96% from the West are of the NC variety; in the absence of more concrete data, it must be assumed that the denominator is more narrowly defined in this case than the numerator. However, it can be inferred that the preponderance of machine-tool imports from the West are of the NC type, while CMEA machines at this end of the technology spectrum are a small fraction of total CMEA deliveries.

The flows for 1983 are corroborated by the data on the stocks of Hungarian NC machine tools reflected in the SPE listings through the first quarter of 1984. Western NC machines accounted for 41% of the value of the stock of NC lathes (19% of the total number of such units), 56% (31%) of NC milling machines, 74% (56%) of NC drilling machines, and 79% (57%) of all other NC types listed by the SPE. Available data shed some light on the role played by these machines. The calculated per-

[12]The Machine Tool Programming Association, (or SPE in its Hungarian acronym.)

unit costs of Western NC machines is generally more than double the weighted average of domestic and other CMEA costs for each type. A calculation of the coefficient of variation[13] of implied prices for each of these NC machine types is presented in Table 8. The data show a uniformly greater dispersion of prices for Western NC machine tools. Since these statistics are derived from stock rather than flow data, part of the difference in coefficients of variation may be attributable to a greater tendency for inflation to affect Western machinery prices over time than is true for CMEA machines.[14] However, the coefficients may imply that Western imports play a different role in Hungarian development schemes than do either domestic or other CMEA equipment. The greater dispersion of prices could be caused by a wider variation in the characteristics of the machines imported. While Hungary and the CMEA may concentrate on producing relatively few machine types that take care of the bulk of machining jobs, Western machines may be acquired along a wider range to fill the gaps left by the absence of particular machine types in CMEA output. In this sense, the addition of a few Western NC machines not otherwise available within the CMEA may be required to complete an enterprise's complement of machine tools and render the whole, including the CMEA machines, more effective. Further, it may be supposed that machines acquired to occupy the niche at the higher end of the technological sophistication and performance spectrum may be disproportionately Western and therefore considerably more expensive than even the Western mean. This too would lead to a greater dispersion, as well as greater skewedness, in the prices of Western machine tools. If these suppositions are true, reliance in this sense may bespeak some degree of dependence: substitutes may not presently exist within the CMEA for some fraction of the NC machine tools imported from the West.

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[13]The standard deviation divided by the mean, a measure of central tendency.

[14]The official price index on total machinery investment indicates that prices for domestic machinery increased 19 percent between 1975 and 1983, while imported-machinery prices increased by 27% (*Statisztikai Evkonyv*, 1983).

The Decision to Import from the West

As noted earlier, the importing of Western technology by an East European country does not *ipso facto* imply dependence. In part, a concept of dependence must be concerned with the available recourse if existing East-West commodity flows were to be halted. In the case of Hungary, enterprises themselves are responsible for investment decisions, and, more than elsewhere in the CMEA, managers are conscious of and motivated by costs. It may be, therefore, that the actual flow of Western NC machinery is determined by the relative cost of equipment. Given the choice between comparable Western and CMEA NC machine tools, a prudent manager might consider the technical characteristics of the equipment in relation to price and decide to import from the West. If prices changed in favor of the CMEA machine, or if faced with export controls or other barriers to Western imports, the manager may shrug his shoulders and purchase the CMEA equipment; the decision is made for him. This raises the question of whether NC machines are purchased from the West because such imports have a very low elasticity of substitution with respect to their CMEA alternatives, or because the relative costs of the alternatives make importing from the West expedient and efficient.

Equation 4 serves as a simple model of the import decision faced by Hungarian enterprise managers. Expenditures on Western NC equipment depend on a budget constraint and a ratio of Western to CMEA machine prices. Price data from 1972 to 1983 were used to run the regression detailed in Eq. (4).

$$\underset{}{\text{LNWEST}} = \underset{}{-3.2831} + \underset{(0.1516)}{1.2253}\ \text{LNTOTAL} + \underset{(0.2320)}{0.6219}\ \text{LNPRAT} - \underset{(0.0484)}{0.1287}\ \text{T} \qquad \text{EQUATION 4}$$

R squared = 0.97 DF = 8 n = 12

The logarithm of the total expenditure on Western NC machine-tool imports by year (LNWEST) for 1972 to 1983 was regressed on the logarithm of total expenditure for NC machine-tool acquisitions from all sources (LNTOTAL), the logarithm of the annual ratio of average Western NC

prices to a weighted average of Hungarian and other CMEA NC machinery prices (LNPRAT) and a linear time trend (T).[15] The numbers in parentheses are standard errors; all coefficients are significant to the 0.98 level.

The estimated coefficient of the LNTOTAL term, expenditure on all NC machine tools acquired in a given year, has the expected sign if the variable is interpreted as a measure of available investment resources. The size of the coefficient indicates that the demand for Western NC imports is elastic with respect to a budget constraint. This interpretation is not fully satisfactory, since the assumption of independence for LNTOTAL in this functional form is problematic and no account is taken of hard currency constraints or of notional demand left unexpressed due to import and export controls of various kinds, but the result accords with intuition.

The coefficient of the price ratio appears perverse: It suggests that the greater the price ratio, the greater is the desire for Western imports.[16] It should be remembered that the Hungarian enterprise manager, more than managers in any other East European country, makes the acquisition decision based on domestic prices that reflect accurately the unsubsidized import cost of Western capital, pays import duties on top of the basic price, and is supposed to work within an enterprise budget.[17] Two interpretations can be offered in explanation.

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[15]The current values for LNWEST and LNTOTAL were deflated by the official indices of non-Socialist imported machinery investment prices and of total machinery investment prices, respectively (*Statisztikai Evkonyv*, various years).

[16]If the regression is run without inclusion of the time trend (T), the coefficient on the relative price variable is still positive, although no longer significant. The time trend was included to provide a proxy for changes during the period that would otherwise call the assumption of *ceteris paribus* into question. The linear time trend in the model is a simple specification, although it probably reflects well the accumulating experience with NC technology and a growing intra- and extra-enterprise infrastructure that would tend to alter the demand for Western NC technology.

[17]This oversimplifies the case. An actual allocation of hard currency must be made by central authorities, and import permits must be obtained. Further, the enterprise budget constraint has been subject to some manipulation throughout the period discussed.

There may, in fact, be dependence on the West for machine types not available in CMEA. The higher price may reflect a higher technical standard. A certain number of the machines are vital to the proper performance of individual Hungarian machine shops (i.e., are relatively noncompressible), so their higher price would naturally be reflected in higher expenditures.

A second explanation focuses upon qualitative differences. Prices of Western machines may be increasing in real terms relative to those of CMEA machines but actually *decreasing* if weighted by qualitative differences. The relative index of quality may be changing more rapidly in favor of the West. The decade of the 1970s was precisely the period when the earlier form of NC technology using relatively simple digital decoders and punched-paper programs was giving way to the more sophisticated forms of internal microelectronic circuitry embodied in computer NC (CNC) equipment. These qualitative changes were incorporated much more rapidly in Western equipment than in CMEA equipment, even equipment constructed on the basis of license purchases from the West. This leads to the hypothesis that much of the imported Western equipment was of an altogether different technological type than that produced and available for trade within the CMEA. If so, considering the central role of NC machine tools in East European development schemes, this would strengthen the case for interpreting reliance as an indication that Western imports are fulfilling a need not easily met by CMEA sources.

V. CONCLUSIONS AND IMPLICATIONS FOR POLICY

The calculation of Western import reliance measures for each country by discrete technology commodity groups is a useful, if inconclusive, exercise in establishing the degree of potential dependence on Western technology imports. It indicates that there is a good deal of variation in the degree of import reliance between the countries of Eastern Europe and among technology groups. To think of the phenomenon of technology transfer only in terms of the more aggregate categories of "Eastern Europe" and "high technology" is to miss most of this variation.

Variability in the volume of technology imports from the West stems from differences in domestic economic cycles, the status of international trade and payments, relations with the West, and fundamental political choices. The last of these is strongly subject to influence by the policy choices made by the West, on the one hand, and the Soviet Union, on the other.

The data used in this study are not adequate to answer conclusively the questions of whether the technological level of Eastern Europe as a whole is rising or whether an individual country's degree of import reliance changes with rising technological level. The import reliance measures of technologically advanced East Germany and Czechoslovakia are relatively low, but these results may be anomalous. The East German measures are calculated without data on the massive flow of technology from the FRG, which goes unreported. Czechoslovakia's case seems dominated by political choices that have also contributed to a decline in the country's technology base.

The Bulgarian experience is that of a less-developed country attempting to rapidly change its technology base. Bulgarian reliance on Western technology imports is thus relatively heavy. Coupled with the findings on the role played by Western machine-tool imports in Hungary, the Bulgarian case suggests that it is not yet possible for an East European nation to forgo imports of technology from the West when modernizing the base of its industry.

The ability of the United States to form meaningful policy independent of other developed Western exporters is limited by the fact that the United States accounts for only a small share of Western sales to the CMEA. This also complicates the fashioning of collective policies on denial of specific dual-use technologies, since the domestic consequences of such policies usually have a greater effect on other members of COCOM than on the United States.

The rapidity of technological change in the developed West and the diffusion to the developing nations of the ability to manufacture high-technology components will undermine the power of the United States and other developed Western nations to monitor and control technology flows

to the CMEA. While much of this diffusion takes place under the auspices of Western multinational corporations which theoretically can be made to conform to guidelines on technology export, the enforcement problem becomes more difficult as the number of players in the game increases.

This is certainly not to suggest that the policy of control should be abandoned or that a policy of deliberately increasing high-technology commodity trade with the CMEA should replace it as a means for increasing Western influence. For one thing, the countries of the region are becoming increasingly sophisticated about their ability to sustain sizable imports of technology based upon the ability to earn hard currency. This has led to policy changes in Eastern Europe that will naturally have an effect on demand. In the future, there will be increased emphasis on alternative means for obtaining Western technology, such as cooperation agreements, licensing, joint production, and other forms of disembodied transfer. Moreover, there is continuing legitimate concern for collective Western security with regard to the transfer of militarily useful technology.

On the other hand, policies of denial should not be predicated on the simple syllogism that the transfer of technology necessarily means handing over to the existing regimes a panacea for all problems of development. While the term *technology* must be decomposed by commodity, if one is to speak accurately, the experience of the 1970s and 1980s is that technology has flowed, yet profound economic problems remain. A distinction should be made between gaps in the technological levels of East and West that are due to differential access to leading-edge technologies and gaps caused by a relative inability or lag in applying those technologies that are made available to all. Acquisition and implementation are two different issues.

Technology transfer itself is disruptive. It rarely resembles the simplified process portrayed in economic theory. In many instances, when technology developed in one country is transferred to another--even another at the same technological level--the results are not immediately satisfactory, and the transfer reveals unsuspected problems of organization and management.

Although the original intent of importing Western technology was to provide quick fixes for the economies of Eastern Europe in lieu of systemic reform, specific and general instances of problems with absorption and effective utilization may lead to a widening perception in the importing nations that reform is imperative. In other words, when advanced machinery of a known productive capacity fails to live up to expectations in its new environment, the rigidities within the enterprise, the sector, and the surrounding economic milieu are called into question.[18] It may well be that by acquiring the technology from the West rather than developing it domestically, the East Europeans are multiplying this effect. The imported technology tends to be more revolutionary, not evolved from familiar expertise and industrial relationships, and is thus more jarring. If decentralization of the economic systems in Eastern Europe is viewed as a desirable object of policy by the West, a more sophisticated view of technology transfer as a means to that end might be warranted.

A search for a more active role for technology in serving Western policy ends need not necessarily require any change in current policies on export controls. East Europeans at the level of enterprise and industrial-sector management generally believe that COCOM is more broadly focused and active than it actually is. Much Western technology that is of great use to East European industry is continuously flowing from West to East. Western policy should explicitly emphasize at various levels of East-West contacts the true porousness of the technology embargo bogey that has been raised by the Soviet Union. To the extent that there is a general policy purpose to be served in demonstrating a commonality of interests between the West and Eastern Europe, the current flow of high-technology commodities is a highly tangible manifestation of that connection.

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[18]The new technology need not, in fact, be very highly advanced to elicit this effect. Simply being "foreign," that is, of a type different from what has previously been used in a given enterprise setting, may be quite sufficient for the technology to induce reappraisals of existing management systems (see Popper, 1985).

APPENDIX

Table 1

WESTERN IMPORT RELIANCE MEASURES FOR CENTRIFUGES, PURIFICATION AND FILTRATION APPARATUS, NONLIQUID PUMPS, AND COMPRESSORS (SITC 743)[a]

Country	1980	1980[b]	1981	1982	1983	1983[b]	1984
Yugoslavia	0.99	[0.99]	0.99	0.93	0.98	[0.95]	0.99
Bulgaria	0.50	[0.41]	0.55	0.78	0.83	[0.71]	0.75
Czechoslovakia	0.60	[0.60]	0.61	0.64	0.62	[0.55]	0.64
GDR	0.35	[0.35]	0.32	0.75	0.64	[0.61]	0.49
Hungary	0.77	[0.74]	0.80	0.87	0.88	[0.84]	0.89
Poland	0.76	[0.72]	0.49	0.64	0.63	[0.60]	0.72
Rumania	0.74	[0.68]	0.64	0.38	0.38	[0.28]	0.39
USSR	0.63	[0.63]	0.46	0.66	0.73	[0.73]	0.45

SOURCE: UNECE, various years.

[a]Does not include Rumanian or Soviet exports, or exports from the FRG to the GDR.

[b]Includes Soviet exports.

Table 2

WESTERN IMPORT RELIANCE MEASURES FOR METAL-WORKING MACHINE TOOLS (SITC 736)[a]

Country	1980	1980[b]	1981	1982	1983	1983[b]	1984
Yugoslavia	0.79	[0.75]	0.75	0.73	0.70	[0.63]	0.73
Bulgaria	0.25	[0.18]	0.41	0.42	0.54	[0.43]	0.49
Czechoslovakia	0.50	[0.38]	0.39	0.40	0.39	[0.31]	0.42
GDR	0.39	[0.30]	0.43	0.39	0.39	[0.30]	0.19
Hungary	0.52	[0.45]	0.45	0.35	0.42	[0.36]	0.40
Poland	0.64	[0.46]	0.67	0.57	0.32	[0.24]	0.31
Rumania	0.50	[0.42]	0.30	0.10	0.22	[0.15]	0.10
USSR	0.55	[0.55]	0.47	0.40	0.41	[0.41]	0.32

SOURCE: UNECE, various years.

[a]Does not include Rumanian or Soviet exports, or exports from the FRG to the GDR.

[b]Includes Soviet exports.

Table 3

CHANGE IN STANDARD IMPORT RELIANCE MEASURES FOR METAL-WORKING MACHINE TOOLS RESULTING FROM SOVIET DELIVERIES

(Percentage)

Country	1980	1983	Change
Yugoslavia	5.0	10.0	5.0
Bulgaria	28.8	20.8	-8.0
Czechoslovakia	24.2	18.4	-5.8
GDR	23.4	23.3	-0.1
Hungary	13.9	15.4	1.5
Poland	27.9	23.0	-4.9
Rumania	16.5	33.6	17.1

SOURCE: UNECE, various years.

Table 4

WESTERN IMPORT RELIANCE MEASURES FOR AUTOMATIC DATA PROCESSING EQUIPMENT (SITC 752)[a]

Country	1980	1981	1982	1983	1983[b]	1984
Yugoslavia	0.99	0.92	0.90	0.78	[0.78]	0.81
Bulgaria	0.17	0.15	0.17	0.14	[0.11]	0.25
Czechoslovakia	0.21	0.13	0.10	0.08	[0.06]	0.06
GDR	0.12	0.11	0.04	0.13	[0.09]	0.03
Hungary	0.36	0.13	0.22	0.15	[0.12]	0.20
Poland	0.46	0.14	0.10	0.10	[0.08]	0.08
Rumania	0.55	0.19	0.15	0.04	[0.04]	0.10
USSR	0.12	0.07	0.04	0.04	[0.04]	0.05

SOURCE: UNECE, various years.

[a]Does not include Rumanian or Soviet exports, or exports from the FRG to the GDR.

[b]Includes Soviet exports.

Table 5

SHARE OF TECHNOLOGY-SAMPLE IMPORTS IN TOTAL MACHINERY IMPORTS FROM THE WEST

(Percentage)

Country	1980	1981	1982	1983	1984
Yugoslavia	12.3	11.2	13.8	14.7	15.2
Bulgaria	10.2	11.9	17.4	22.8	19.4
Czechoslovakia	14.2	13.9	14.5	15.4	15.3
GDR[a]	14.6	15.1	15.8	14.9	10.7
Hungary	12.4	11.7	10.8	12.3	14.1
Poland	5.1	18.9	21.2	15.1	13.6
Rumania	22.0	17.3	9.4	17.5	10.2
USSR	20.7	16.2	13.9	16.6	16.1

SOURCE: UNECE, various years.

[a]Does not include exports from the FRG to the GDR.

Table 6

TRADE-WEIGHTED WESTERN IMPORT RELIANCE MEASURES FOR ALL TECHNOLOGY-SAMPLE COMMODITIES[a]

Country	1980	1980[b]	1981	1982	1983	1983[b]	1984
Yugoslavia	0.77	[0.76]	0.84	0.84	0.78	[0.73]	0.82
Bulgaria	0.21	[0.17]	0.31	0.39	0.49	[0.39]	0.40
Czechoslovakia	0.35	[0.30]	0.28	0.28	0.24	[0.19]	0.23
GDR	0.27	[0.23]	0.25	0.24	0.26	[0.20]	0.12
Hungary	0.46	[0.43]	0.42	0.41	0.38	[0.31]	0.37
Poland	0.49	[0.41]	0.45	0.47	0.31	[0.25]	0.31
Rumania	0.47	[0.41]	0.30	0.13	0.19	[0.14]	0.12
USSR	0.38	NA	0.23	0.23	0.25	NA	0.19

SOURCE: UNECE, various years.

[a]Does not include Rumanian or Soviet exports, or exports from the FRG to the GDR.

[b]Includes Soviet exports.

Table 7

RATIO OF AVERAGE WESTERN IMPORT RELIANCE MEASURES FOR ALL TECHNOLOGY-SAMPLE COMMODITIES TO AVERAGE WESTERN IMPORT RELIANCE MEASURES FOR ALL OTHER SITC 7 COMMODITIES[a]

Country	1980	1980[b]	1981	1982	1983	1983[b]	1984
Yugoslavia	1.11	[1.08]	1.02	1.08	1.02	[1.08]	1.08
Bulgaria	1.42	[1.12]	0.81	1.15	1.49	[2.38]	1.25
Czechoslovakia	1.54	[1.30]	0.98	0.91	0.96	[1.03]	0.99
GDR	2.07	[1.76]	1.06	1.04	1.02	[1.14]	0.74
Hungary	2.05	[1.88]	1.06	1.10	1.25	[1.49]	1.35
Poland	0.98	[0.79]	1.28	1.79	1.26	[1.39]	1.20
Rumania	1.45	[1.21]	0.84	0.48	0.90	[1.01]	0.55
USSR	1.54	NA	0.94	0.74	0.85	NA	0.80

SOURCE: UNECE, various years.
[a]Does not include Rumanian or Soviet exports, or exports from the FRG to the GDR.
[b]Includes Soviet exports.

Table 8

COEFFICIENTS OF VARIATION OF NC MACHINE-TOOL PRICES BY TYPE AND ORIGIN

Origin	Lathes	Drilling Machines	Milling Machines	Other
Hungary	0.39	0.53	0.39	0.34
Other CMEA	0.40	0.22	0.40	0.09
West	1.37	1.14	1.67	0.57

SOURCE: SPE data.

APPENDIX

DATA ON IMPORT RELIANCE

Commodities in the Technology Sample

Three criteria were employed in choosing the categories for calculating Western import reliance measures: availability and comparability of data, judgment that the commodity group represents a set of goods that might be considered to possess higher technological characteristics than those in other SITC categories,[19] and that the category be sufficiently disaggregated to provide reasonable assurance that the bulk of the commodities were truly the types of interest.[20]

[19]All the goods constituting the technology sample for this study appear on the list of high-technology commodities developed by the U.S. Department of Commerce (Lenz and Stiltner, 1985).

[20]In addition to the commodity groups presented in this paper, the full study also examined metal-working machine tools disaggregated into metal-cutting and metal-forming machine tools (SITCs 736, 736.1, 736.2);

Country Data

All measures of reliance on Western imports were constructed by aggregating mirror export data for seventeen developed Western countries and dividing by total imports from those countries and from the European CMEA countries.[21]

The denominator included all imports from the developed Western countries listed above,[22] plus imports from those CMEA countries that were reported in the UNECE listings, i.e., Bulgaria, Czechoslovakia, the GDR, Hungary, and Poland. Imports from the Soviet Union were reported only in 1980 and 1983. No Rumanian figures were reported for 1980-1984. In 1976, the last year Rumanian data were reported in the UNECE reports, Rumanian exports were 4.2 percent of the total of intra-CMEA trade in the commodities of SITC 7, machinery and transportation equipment, and 8.2 percent of trade within the East European Six. It may be presumed that Rumania's share in high-technology trade was somewhat less.

The Data Source

Shortcomings stemming from the use of the UNECE data are of two types. The first is in the nature of the reporting. Western data are reported directly to the UN Statistical Office, and the UNECE data

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telephonic and telegraphic communications equipment (SITC 764.1); television, radio, and radiotelegraphic transmitters (SITC 764.3); other telecommunication equipment (SITC 764.8); and microcircuits (SITC 776.4). A heterogeneous category of scientific and controlling apparatus (SITC 87), photographic apparatus (SITC 881), optical equipment (SITC 884), and watches and clocks (SITC 885) was studied but was not included in the technology sample.

[21]The Western countries included in the sample were Austria, Belgium-Luxembourg, Canada, Denmark, Finland, France, West Germany (the FRG), Ireland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The sample originally included Brazil, Australia, Greece, and Portugal, but these countries were dropped due to the virtual absence of exports from them to Eastern Europe in the categories of interest.

[22]In theory, we would want the denominator to include imports from all sources. The problems of including all of them are practical rather than theoretical. Based on the data available in the UNECE database, this exclusion has little effect on the findings. The direction of any resulting bias to the import reliance measures should be downward. A second problem is that only major exporting countries are included in the UNECE data. To include such sources as Taiwan, South Korea, and Singapore would require going to other sources and thereby raising problems of nonisomorphic data. Again, the inclusion of this subset of potential exporters would not vitiate the study's findings on revealed reliance, but it would suggest a different relative importance for exports that originated outside COCOM.

derive from that source. A major problem is caused by the omission of West German deliveries to the GDR.

The UNECE secretariat receives data directly from the countries of the CMEA. These data are originally submitted either directly in U.S. dollars or in national currencies that are then converted into dollars at the official rate. For some countries, the original data must be restated in terms of the commodity groupings of SITC revision 2 to be comparable. Therefore, a series of judgments, not explicitly treated, is made to include the CMEA data in the unified listings.

The greater problem is that of valuation. All data are reported in millions of current U.S. dollars, f.o.b. One difficulty is the volatility of dollar exchange rates. This problem, while perplexing, is not as great as it might have been. Only the last two years of the 1980-1984 period experienced dramatic changes. Further, direct exports of technology goods by the United States to the countries of Eastern Europe constitute only a small fraction of total Western exports. Therefore, most of the Western exports were originally stated in currencies that moved roughly in the same direction with respect to the dollar.

The problem is more serious in the case of CMEA data. Some currencies, such as the Hungarian forint and the Polish zloty, also moved at approximately the same rate as Western currencies in relation to the dollar. For others, official exchange rates were relatively fixed and, as is well known, unresponsive to real influences and even divorced from a need for internal or cross-national consistency. Further, while policies in the CMEA mean that the prices for homogeneous goods and raw materials approximate (with a lag) world market prices, machinery prices within the CMEA are notoriously subject to manipulation, making assessments of true relative worth problematic. The main shortcoming in using the UNECE data is that the assumptions made in aggregation by UNECE are necessarily unobservable.

Systematic Biases in the Import Reliance Measures

The import reliance measures would be affected if there were significant exclusions in the reporting of exports by CMEA countries. The implicit assumption of the measure is that if exports are reported for a category of goods, they represent the total of all such exports. It is further assumed that export totals represent goods actually exported, not those scheduled for delivery, and that deliveries of military or other goods are not masked by inflating the totals of some commodity groups.

Systematic downward biases in the import reliance measures would stem from rigidities in foreign exchange adjustments by CMEA countries in a period when the dollar numeraire was appreciating. This would tend to overvalue CMEA exports in dollar terms. Further, it is generally accepted that due to the institutions of CMEA trade, the prices of East European machinery are inflated somewhat in comparison with world prices

for machine types with similar characteristics. The size and scope of this overstatement is subject to debate. The net effect would be a downward bias in import reliance measures. This could be offset by a compensating bias if inflation in the prices of Western machinery proceeded more rapidly than price increases in their CMEA counterparts. It is not clear that this happened, however, during the period in question.

Finally, it should be noted that the data used to calculate import reliance do not reflect exports by countries not enumerated above, such as the industrializing nations of Asia; covert or illegal acquisition of high-technology capital goods; or the reexport of goods from the original destination to another country.

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